

The Corticolous Species of the Lichen Genus *Rinodina* (Physciaceae) in Temperate Australia

H. Mayrhofer¹, G. Kantvilas² and K. Ropin³

¹Institut für Botanik, Karl-Franzens-Universität Graz, Holteigasse 6, A-8010 Graz, Austria.

²Tasmanian Herbarium, GPO Box 252-04, Hobart, Tasmania 7001, Australia.

³Johann-Nestroy-Gasse 9/8, A-8605 Kapfenberg, Austria.

Abstract

A revision of corticolous and lignicolous species of the genus *Rinodina* (Ach.) Gray (lichenized Ascomycetes, Physciaceae) in temperate Australia is presented. Eight taxa are treated, of which two are described as new: *Rinodina confusa* H. Mayrhofer & Kantvilas and *R. elixii* H. Mayrhofer, Kantvilas & Ropin. The most important characters are outlined briefly and a key to the taxa is provided. Excluded taxa, including *Amandinea insperata* (Nyl.) H. Mayrhofer & Ropin *comb. nov.*, are also discussed. *Rinodina australiensis* Müll. Arg., *R. conradii* Körb. and *R. dolichospora* Malme are lectotypified.

Introduction

Rinodina is a cosmopolitan genus of approximately 200 species (Hawksworth *et al.* 1995) belonging to the large lichen family, Physciaceae. It is characterised by a generally crustose thallus, a *Trebouxia*-like photobiont, mostly lecanorine apothecia, *Lecanora*-type asci (Rambold *et al.* 1994), brown, septate ascospores with characteristic wall thickenings, and bacilliform spermatia. *Rinodina* species occur on a wide range of substrates including bark, wood, bryophytes and rock. Revisionary studies in recent decades have dealt with species from the British Isles (Sheard 1967), Antarctica (Lamb 1968), the Benelux (Giralt *et al.* 1997), saxicolous species from Europe (Mayrhofer & Poelt 1979), New Zealand (Mayrhofer 1983), Europe, Africa and Asia (Mayrhofer 1984a), Australia (Mayrhofer 1984b), the Iberian Peninsula (Giralt & Barbero 1995; Giralt & Llimona 1997), Southern Africa (Matzer & Mayrhofer 1996), and corticolous species from the Eastern Alps in Central Europe (Ropin & Mayrhofer 1993), southern Europe and adjacent regions (Giralt & Matzer 1994; Giralt & Mayrhofer 1994a; 1994b; 1995; Giralt *et al.* 1995).

In the Australian region, 35 species have been recorded in the checklist of Filson (1996), including 14 from Tasmania (Kantvilas 1994). The saxicolous taxa (20 species) have been revised by Mayrhofer (1984b) with further studies and additional taxa reported by Mayrhofer *et al.* (1990), Matzer & Mayrhofer (1994), and Matzer *et al.* (1998). However, the corticolous species remain poorly known and those occurring in Tasmania and the temperate regions of Australia are the focus of the present paper.

Material and methods

The study is based on specimens from the following herbaria: B, BRI, CANB, COLO, G, GZU, H, HO, L, MEL, PERTH, S, STU, UPS, the private collection of Klaus Kalb, and on the field observations of the authors in a wide range of habitats and localities in Tasmania and mainland Australia. Anatomical investigations were made using standard light microscope techniques and measurements were derived from hand-cut sections mounted in water. Routine chemical analyses for the investigation of lichen compounds were undertaken using the standard methods of Culberson & Ammann (1979) and Culberson & Johnson (1982). The study area comprises Tasmania and the southern Australian mainland. However, numerous collections from New Zealand and subtropical Australia were also studied for comparative purposes.

Taxonomic characters in *Rinodina*

Morphology

The gross morphology of the thallus of the species studied is very variable and clearly influenced by habitat and other factors. Nevertheless, a group of species have a very well developed, \pm subsquamulose thallus, rather reminiscent of some smaller members of the family Pannariaceae. Thus, at least for these taxa, thallus morphology provides a valuable aid to identification. The formation of blastidia [yeast-like propagules budded from the thallus surface (Poelt 1980)] can be a useful character for recognising *Rinodina australiensis*.

Ascospores

Ascospores, notably their size and, more particularly, their characteristic apical and median wall thickenings, have traditionally been the fundamental character for defining the species (Poelt & Mayrhofer 1979, revised compilations by Hafellner *et al.* 1979, Mayrhofer & Poelt 1979, Mayrhofer 1982, 1984a, and modified by Matzer & Mayrhofer 1996). The presence or absence of a torus (i.e. a dark belt in the region of a spore septum) is not always a reliable character for the definition of spore types (Scheidegger 1993, Matzer & Mayrhofer 1996).

The mode of ascospore ontogeny was stressed as being an important character by Giral (1994) and Giral & Mayrhofer (1994a, 1994b, 1995). Two main ontogenetic types

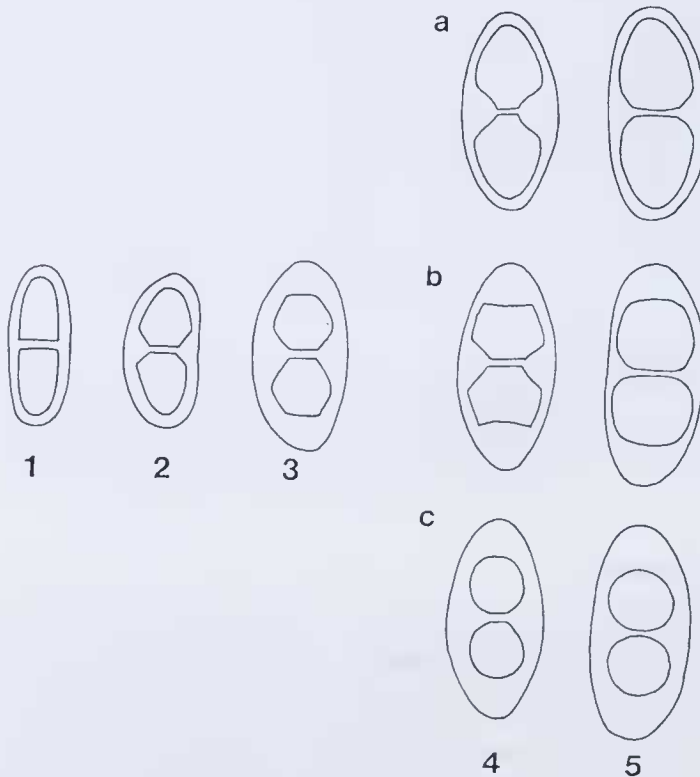


Fig. 1. Ascospore ontogenies and ascospore-types: ontogeny of type A: **a** *Physconia*-type ascospores; **b** *Physcia*-type ascospores; **c** *Pachysporaria*-type ascospores. - (1) to (5) sequence of ontogeny-stages (after Giral & Mayrhofer 1995: 130).

can be observed with respect to the insertion of the septum, which occurs in the earlier stages of ontogeny when the ascospores are still unpigmented: type A, where apical internal spore wall thickenings appear after the insertion of the septum (Fig. 1), and type B, where apical internal wall thickenings appear before the insertion of the septum (Fig. 2). Five stages of ascospore ontogeny can be identified within type A (Fig. 1): (1) septum formation; (2) thickening of the lateral walls at the septum; (3) thickening of the apical walls. Stages 1-3 occur in premature unpigmented ascospores. Stage 4 shows pigmented mature ascospores with the distinct internal wall thickenings that define the ascospore types, whereas stage 5 refers to overmature ascospores with walls becoming more or less uniformly thick. In contrast, ascospores with an ontogeny of type B show apical internal wall thickenings (1) before the insertion of the septum (2) and the thickening of the lateral walls at the septum (3) (Fig. 2). With the exception of *Rinodina conradii* all the taxa treated follow type A ontogeny.

Within the species investigated in detail in the present study, the following types of ascospores were observed:

- (i) *Physconia*-type: ascospores with \pm pronounced septal wall thickenings, apical thickenings less pronounced or lacking, and lumina rounded at their distal ends; found in *R. pyrina*.
- (ii) *Physcia*-type: septal and apical wall thickenings well developed, spore lumina concave at their distal ends, torus usually developed; found in *R. confusa*, *R. elixii* and *R. obscura*.
- (iii) *Mischoblastia*-type: septal and apical wall thickenings strongly pronounced, forming extremely angular lumina; found in *R. australiensis*.
- (iv) *Pachysporaria*-type: wall thickenings strongly developed around the lumina which are \pm rounded; found in *R. asperata*, *R. australiensis*, *R. confusa* and *R. dolichospora*.
- (v) *Conradii*-type: uniformly thickened walls and four rounded lumina; found in *R. conradii*.
- (vi) *Orcularia*-type: wall thickenings only at the septum; found in *Amandinea insperata*.

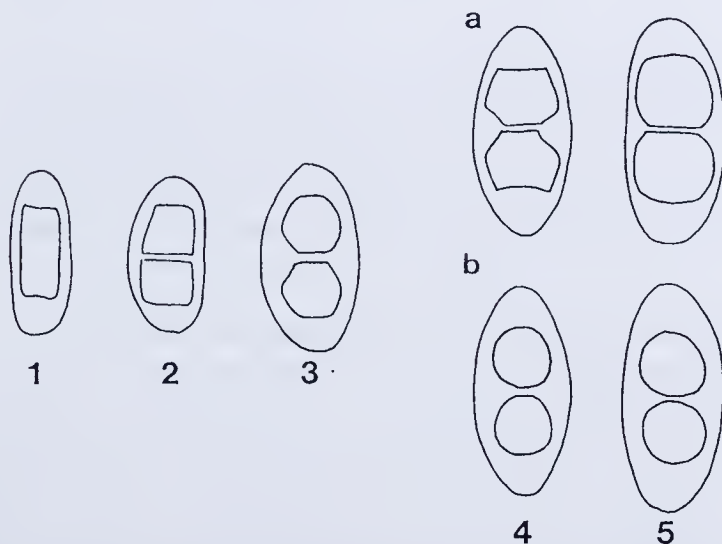


Fig. 2. Ascospore ontogenies and ascospore-types: ontogeny of type B; **a** *Dirimaria*-type ascospores; **b** *Pachysporaria*-type ascospores. - (1) to (5) sequence of ontogeny stages (after Giralt & Mayrhofer 1995: 132).

Note that in two species (*R. australiensis* and *R. confusa*) the ascospores could not clearly be assigned to a single spore type. All ascospore characters (wall thickenings, shape of lumina, torus, ornamentation) can be observed in water mounts. However, mounting in dilute KOH is recommended when the material is fresh.

Hymenium

An interesting anatomical feature of some species is the 'oil paraphyses' that are characterized by the presence of distinctly enlarged cells ('oil cell') with oil-like contents. Such structures were originally described by Poelt & Pelletter (1984) and Giralt *et al.* (1992) in some species of *Caloplaca*, and they have also been detected in some species of *Rinodina* (Giralt & Mayrhofer 1994a, Giralt & Matzer 1994, Matzer & Mayrhofer 1994).

Photobiont

The photobiont of the species studied is an unidentified green alga with roughly roundish or broadly elongate cells. The size of the cells appears to be consistent for the species, and thus provides an additional taxonomic character. Two broad size classes are discernible: generally <10 µm across and from 10 µm to as much as 20 µm across.

Anatomy of the exciple

Characters of the exciple, for example, the degree of development of the parathecium, cortex and epinecral layer, have been described and measured for all species, although these are probably of limited use as taxonomic characters. In part, these relate to the age of the apothecia or to features of gross morphology, such as whether they are immersed, adnate or sessile. Furthermore, these characters, especially the development of the epinecral layer, may well be related to habitat.

Ecological and biogeographic patterns

The majority of the species studied, i.e. *R. asperata*, *R. australiensis*, *R. confusa*, *R. elixii* and *R. obscura*, are found mainly in dry sclerophyll woodland. These species are all endemic to temperate Australia, as are their host trees and shrubs, for example, species of *Acacia*, *Allocasuarina*, *Banksia*, *Callitris*, *Exocarpos* and *Melaleuca*. *Rinodina australiensis* also occurs in mangroves, as does *R. dolichospora*, which was first described from Brazil. Of the remaining species treated, *R. pyrina* is probably introduced from Europe, as are its hosts, whereas *R. conradii* is a pantemperate species quite unrelated to the other taxa in the study area. The relatively high level of endemism of corticolous species contrasts sharply with that displayed by the Australian saxicolous *Rinodina* flora, in which most species also occur in New Zealand and/or other adjacent regions, or are cosmopolitan (Mayrhofer 1984b, Mayrhofer *et al.* 1990, Matzer & Mayrhofer 1994, Matzer *et al.* 1998, Mayrhofer & Matzer, in prep.).

Key to corticolous and lignicolous *Rinodina* in temperate Australia

- 1. Ascospores four-celled 2
- 1. Ascospores two-celled 3
- 2. Septum in young ascospores inserted after formation of internal wall thickenings (ontogeny of type B, Fig. 2); lumina of immature two-celled ascospores subsymmetrically circular (*Phlyscia*-type) (Fig. 3A) *R. conradii*
- 2. Septum in young ascospores inserted before formation of internal wall thickenings (ontogeny of type A, Fig. 1); lumina of immature two-celled ascospores bone-shaped (Fig. 3B); a species of subtropical and tropical rainforests
 *R. connectens* Malme (not treated)

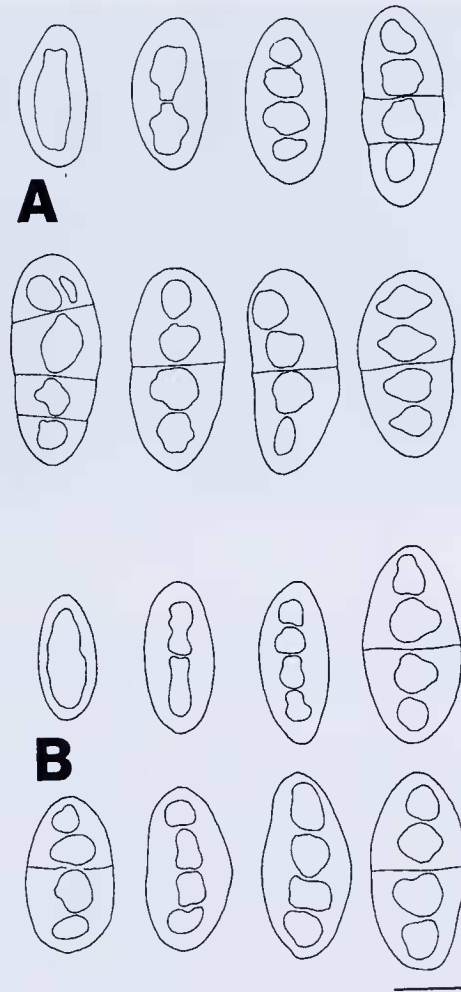


Fig. 3A. Ascospores of *Rinodina conradii* (Walpole National Park, Tibell 14099, GZU); first row: ontogeny; second row: mature ascospores; **3B.** Ascospores of *Rinodina connectens* (Atherton Tableland, Mt Lewis, 18.iv.1968, W.A.Weber, COLO); first row: ontogeny; second row: mature ascospores. Scale: 10 μ m.

3. Most ascospores >22 μ m long; thallus usually well-developed, thick, areolate-crustose to subsquamulose.....4
3. Most ascospores <22 μ m long; thallus variable, often relatively thin.....6
4. All ascospores of the *Pachysporaria*-type, frequently with minute grain-like or droplet-like inclusions (Fig. 10c); photobiont cells <10 μ m wide.....*R. dolichospora*
4. All ascospores of the *Physcia*-type, or at first of the *Mischoblastia*-type and then corresponding to the *Pachysporia*-type, without inclusions; photobiont cells generally >10 μ m wide5
5. Apothecia emerging from thalline warts, often with adhering thallus fragments when young; ascospores of the *Physcia*-type*R. elixii*
5. Apothecia \pm adnate to sessile from the earliest stages; ascospores at first of the *Mischoblastia*-type, then corresponding to the *Pachysporaria*-type*R. australiensis*
6. Ascospores generally lacking apical thickenings when mature, of the *Physconia*-type;

- photobiont cells mostly $>15 \mu\text{m}$ wide; a species mainly found on exotic trees in disturbed or modified habitats *R. pyriua*
6. Ascospores with apical thickenings of the *Pachysporaria*-, *Mischoblastia*- or *Physcia*-type or without apical, but with distinct septal, thickenings (*Orcularia*-type); photobiont cells $<15 \mu\text{m}$ wide; species mainly of native vegetation.....7
7. Ascospores without apical, but with distinct, septal thickenings (*Orcularia*-type); spermatia filiform *Anandiuea iusperata*
7. Ascospores with apical thickenings; spermatia bacilliform8
8. Thallus often inapparent to absent; apothecia initially \pm immersed, \pm lecideine when mature; ascospores of the *Physcia*-type *R. obscura*
8. Thallus persistent; apothecia adnate to sessile from the beginning, clearly lecanorine; ascospores of the *Mischoblastia*-, *Physcia*- or *Pachysporaria*-type.....9
9. Thallus rimose-areolate or verrucose; ascospores of the *Pachysporaria*-type
..... *R. asperata*
9. Thallus areolate to subsquamulose, becoming lobulate, granular or microphylline to blastidiate; ascospores at first of the *Mischoblastia*-type or *Physcia*-type, then corresponding to the *Pachysporaria*-type10
10. Ascospores at first with internal thickenings of the *Mischoblastia*-type; torus indistinct..... *R. australiensis*
10. Ascospores at first with internal thickenings of the *Physcia*-type; torus distinct
..... *R. confusa*

1. *Rinodina asperata* (Shirley) Kantvilas, *Pap. Proc. R. Soc. Tasmania* 122: 65 (1988); *Buellia polospora* var. *asperata* Shirley, *Pap. Proc. R. Soc. Tasmania* (1893): 218 (1894), *Type*: Australia, Tasmania, Fork Creek, on bark; W.A. *Weymouth 144* (holotype BRI!, isotype G!).

Exs.: Obermayer: Lichenotheca Graecensis 97 (ASU, B, C, CANB, CANL, E, ESS, G, GZU, H, HMAS, LE, M, MAF, MIN, O, TNS, UPS, Kalb, Vezda)

Thallus crustose, smooth and thin or, more commonly, rather thick, rimose-areolate or verrucose, at times rather abraded, matt, dull olive-green to brownish grey; areoles continuous or \pm dispersed, mostly c. 0.1–0.3 mm wide; prothallus absent. *Photobiont* cells 6–10 \times 5–9.5 μm . *Chemistry*: no lichen substances detected by t.l.c.

Apothecia 0.25–0.8(–1.2) mm diam., typically numerous, scattered or crowded, lecanorine, sessile or adnate. *Thalline margin* prominent, concolorous with the thallus, smooth and entire, or crenulate to verruculose, generally persistent; cortex 15–40 μm thick. *Disc* plane, sometimes becoming markedly convex or uneven with age, brown to blackish brown, matt. *Epithelium* 10–15 μm tall, brown to olive-brown, unchanged in KOH. *Hymenium* hyaline, 70–90(–100) μm tall. *Hypothecium* 60–80(–100) μm deep, hyaline to light yellowish brown. *Paraphyses* simple or branched, not separating easily, 1.5–2 μm thick, with apices pigmented brown to olive-brown, sometimes clavate to capitate, 2–5 μm wide; oil paraphyses sometimes developed. *Asci* eight-spored. *Ascospores* (Fig. 4) two-celled, of the *Pachysporaria*-type, smooth-walled, pale olive to brown, (15–)16–21(–22) \times (7–)8–11(–12) μm ; torus and septum indistinct; ontogeny of type *A. Speriugouia* not observed.

Comments: The *Pachysporaria*-type ascospores of *R. asperata* ally this species with *R. dolichospora*, although these two taxa are readily separable by a wide range of macroscopic and anatomical characters: *R. dolichospora* has substantially larger ascospores, a rather well developed, subsquamulose thallus and apothecia with a frequently incomplete thalline margin. Furthermore, although the two taxa have been



Fig. 4. *Rinodina asperata* (a, b isotype, c *Mayrhofer 5570*): mature ascospores. Scale: 10 μ m.

known to co-occur, they nevertheless tend to have rather different ecologies, *R. asperata* being a dry woodland species whereas *R. dolichospora* is known only from mangroves. In the field and macroscopically, *R. asperata* is more likely to be confused with *R. obscura*, which also has a crustose thallus and occurs in similar dry habitats. Microscopically these two species differ completely because *R. obscura* has *Physcia*-type ascospores with a distinct torus, albeit of similar size. However, even macroscopically they are usually distinguishable, because the thalline apothecial margin in *R. asperata* is usually well developed, whereas in *R. obscura* it is frequently reduced to the extent that the apothecia appear lecideine. Some confusion is also possible between *R. asperata* and *R. pyrina*; these taxa are best distinguished by their ascospores, although they differ further by the larger algal cells of the latter and by their different ecologies (see under *R. pyrina*). Also similar is *R. australiensis*, especially some of the smaller-spored individuals which, like *R. asperata*, occur in dry sclerophyll habitats. This species is distinguished by its generally thicker, crustose to subsquamulose thallus and by its ascospores which are initially of the *Mischoblastia*-type and later develop into the *Pachysporaria*-type.

With respect to the shape and measurements of the ascospores, *R. asperata* comes close to *R. dispersa* Malme described from South America (Malme 1902). The latter species is separated by the well developed, subsquamulose thallus and the mature ascospores that possess a distinct torus.

One specimen [*Wilson 694* from Camperdown, Victoria (G)] remains enigmatic, but we provisionally include it in *R. asperata*. It has ascospores in which the *Pachysporaria*-type thickenings are rather less pronounced than usual but grade instead into the *Physcia*- or *Milvina*-types. With respect to spore and photobiont cell size, this specimen accords well with *R. asperata*. We have also observed short, bacilliform spermatia, $3\text{--}4 \times 1\text{--}1.5 \mu\text{m}$.

Ecology and distribution: *Rinodina asperata* is by far the most common and widespread corticolous species of the genus in the study area, known from southern mainland Australia (all States) and eastern Tasmania (Fig. 5). It occurs in dry sclerophyll forests and open woodlands, mainly in the lowlands but also extending to c. 1400 m above sea level at lower latitudes. It grows on a wide range of understorey trees and shrubs, for example species of *Allocasuarina*, *Acacia*, *Banksia* and *Exocarpos*, and rarely also on *Eucalyptus*. Occasionally it may also occur on exotic trees in modified or disturbed habitats such as pasture, although in such habitats it is more likely to be replaced by *R. pyrina*.

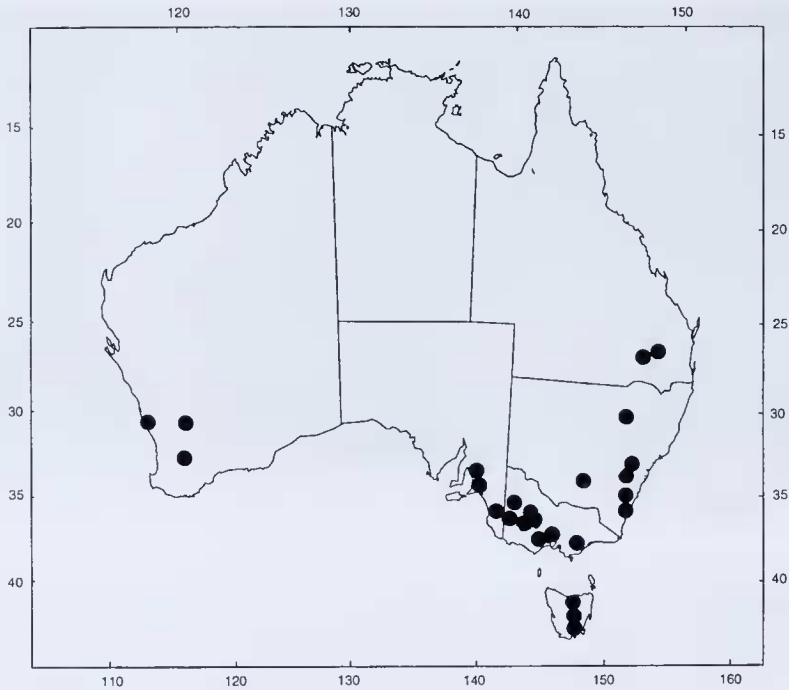


Fig. 5. Distribution of *Rinodina asperata*.

This species grows mainly on living or dead bark of twigs up to *c.* 5 cm diam., and is a typical component of a usually very diverse and well developed association dominated by crustose lichens. Common species with which *R. asperata* often occurs include *Buellia* (*Hafellia*) *dissa*, *Candelariella xanthostigioides*, *Pertusaria gibberosa*, *P. triuera*, *Pyrrhospora laeta*, *Ramboldia brunneocarpa*, *Tephrouzela atra*, unidentified species of *Caloplaca* and the Lecideaceae and Bacidiaceae *sens. lat.*, as well as the macrolichens *Flavoparmelia rutidota*, *Parmelina pseudorelicina* and *Usnea inermis*. Frequently the *Rinodina* is in rather poor condition within this lichen community, and being overgrown by other species, particularly *Candelariella*.

Additional specimens examined: WESTERN AUSTRALIA: Yanchep State Forest, Picnic Area N of Yanchep National Park. N of Perth, *D. M. & H. Mayrhofer 8574*, 28.viii.1988 (GZU); Albany Hwy, 2 km S of Beaufort, S of Arthur River, *D. M. & H. Mayrhofer 8553*, 25.viii.1988 (GZU, HO, PERTH, Mayrhofer); 7793, 7796 (GZU); 8541 (CANB); SE side of Ballidu, *A.S. George s.n.*, 26.iii.1960 (MEL). SOUTH AUSTRALIA: Hillside in Torrens Gorge, near Castanbul, 16 km NE of Adelaide, *M. & H. Mayrhofer 2695*, 12.viii.1981 (GZU); Fred Ratties Scrub, 7 km W of Springton, *M. & H. Mayrhofer 2702, 6657*, 12.viii.1981 (GZU); 6656 (HO); Kuitpo Forest, 10 km E of Willunga, *M. & H. Mayrhofer 6663a*, 14.viii.1981 (GZU); 4700 (HO); Kyeema Conservation Park, 21 km E of Willunga, *M. & H. Mayrhofer 6675, 6678*, 14.viii.1981 (GZU); Christmas Rock, 29 km S of Keith on Dukes Highway, *M. & H. Mayrhofer 2886*, 15.viii.1981 (GZU). QUEENSLAND: Newmarket, Sedgley Park, *R. Rogers & C. Scarlet 4784*, 11.ix.1975 (BRI); Bunya Mountains, Mt Mowbrall, 1050 m, *K. Kalb 21769 & R. Rogers*, 14.viii.1988 (Kalb). NEW SOUTH WALES: New England, Armidale District, 35 km NW of Armidale, Parlour Mountain Area, *H. Mayrhofer 4651 & J. Williams*, 11.x.1981 (GZU); 5405 (HO); Great Dividing Range, Jenolan Caves, SW of Katoomba, *M. & H. Mayrhofer 4649*, 30.ix.1981 (GZU); 5370 (HO); Wanganderry Tableland, Lake Burragorang, near Wollondilly River, E of Byrnes Bay, SSW of 'The Oaks', *H. Mayrhofer 4670*, 3.x.1981 (GZU); Buckenbrowa River Estuary, 7.5 km W of Batemans Bay, *K. Kalb 18787 & J.A. Elix*, 4.viii.1988 (Kalb); Burril Lake, 5 km SW of Ulladulla, *H. Streimann 10685*, 28.xii.1980 (B, CANB, H); Ingalba Nature Reserve, 9 km W of Temora, *J.A. Cunnow 1594*, 5.x.1987 (CANB); Mt

Kaputar National Park, Repeater Station near Kaputar Rocks Lookout, 1450m, *P. Merotsy* 384, 8.ii.1987 (BRI). AUSTRALIAN CAPITAL TERRITORY: Condor Creek, c. 25 km W of Canberra, *H. Mayrhofer* 4658, 1.ix.1981 (GZU); 5344 (HO); Molongolo Gorge Reserve, 14 km E of Canberra, *H. Mayrhofer* 10991, 10993, 26.vii.1992 (GZU). VICTORIA: without locality, *C. Knight* 251, 1887 (G, as *Rinodina obscura*); Maffra, *F.R.M. Wilson* 698, 1891 (G, as *Rinodina metabolica*); Kilmore, *F.R.M. Wilson*, 13.v.1896 (S, as *R. metabolica*); Little Desert, S of Kaniva, *M. & H. Mayrhofer* 5577, 16.viii.1981 (GZU, HO, MEL, Mayrhofer); 6641 (GZU); Little Desert, road from Kaniva to Edenhope, at the mill, 20 km S of Kaniva, *R. Filson* 17078, 16.viii.1981 (MEL); Copi Flats, S of Wyperfield National Park, 125 km N of Horsham, *M. & H. Mayrhofer* 4620, 4695, 18.viii.1981 (GZU); 13266 (GZU, HO); Brisbane Ranges, Little River Gorge, c. 25 km S of Bacchus Marsh, *R. Filson & H. Mayrhofer* 3172, 18.x.1981 (GZU); summit of Ben Nevis, Mount Cole State Forest, 25 km E of Ararat, *M. & H. Mayrhofer* 5570, 5588, 19.viii.1981 (GZU); 1 km N of Wail Forestry Nursery, 4 km SW of Dimboola, *M. & H. Mayrhofer* 2853, 4693, 18.viii.1981 (GZU); northern Grampians, Flat Rock, 25 km SE of Horsham, *M. & H. Mayrhofer* 6686, 17.viii.1981 (GZU); Mount Arapiles Forest Park, 35 km W of Horsham, *M. & H. Mayrhofer* 6639 (GZU, Mayrhofer); Gippsland, Agnes Falls Reserve, NW of Welshpool, *D. & H. Mayrhofer* 11520 & *E. Hierzer*, 29.vii.1992 (GZU); 11525 (GZU, MEL); Gippsland, Buchan Caves Reserve, *D. & H. Mayrhofer* 11551 & *E. Hierzer*, 28.vii.1992 (CANB, GZU). TASMANIA: Mt Wellington, 19.ix.1885. *R.A. Bastow* (H); along road to Bothwell, c. 1 km south of Apsley, *G. Kantvilas* 269/93 & *J.A. Elix*, 7.xii.1993 (HO); Freycinet National Park, Isthmus Track between Wineglass Bay and Hazards Beach, *H. Mayrhofer* 13403, 16.xi.1996 (GZU); Peppermint Hill, approx. 1 km W of New Norfolk, *H. Mayrhofer* 13221, 13415 & *G. Kantvilas*, 19.xi.1996 (GZU); 13414 (HO); Site EE22, 2 km W of New Norfolk along Glenora Road, *G. Kantvilas*, 19.ii.1997 (HO); Site EE25, 2 km S of Howden, near the Powder Jetty, *G. Kantvilas* 192/97, 21.v.1997 (HO); Tasman Peninsula, Cripps Creek, White Beach, *L. Cave*, 5.x.1995 (HO); Hummocky Hills, *A.V. Ratkowsky*, 20.ix.1992 (HO); Grass Tree Hill, *G. Kantvilas* 1014/81, 29.ix.1981 (HO); Launceston, Trevallyn State Recreation Area, *A.V. Ratkowsky*, 12.ii.1992 (HO); Mortimer Bay, *G. Kantvilas* 180/81, 15.iii.1981 (HO); Tunbridge, *G. Kantvilas* 159/98, 9.ix.1998 (HO); Cape Contrariety, *G. Kantvilas* 183/98, 25.ix.1998 (HO).

2. *Rinodina australiensis* Müll. Arg., *Hedwigia* 32: 123 (1893). *Type*: Australia, Victoria, by seaside, on *Banksia serrata*, *F.R.M. Wilson* 368, 1892 (lectotype here designated G!).

Thallus crustose, typically very thick and areolate to subsquamulose, dingy olive-grey to brownish grey; areoles contiguous to \pm discrete, mostly 0.1–0.5 mm wide, convex to unevenly verruculose or minutely lobulate or granular, at times becoming blastidiate; prothallus absent. *Photobiont* cells 10–15 \times 8–14 μ m. *Chemistry*: no lichen substances detected by t.l.c.

Apothecia 0.3–1 mm diam., scattered or crowded, lecanorine, adnate or sometimes sessile, rather sunken when young. *Thalline margin* prominent, entire or sometimes incomplete, smooth to crenulate, generally persistent but becoming rather thin and sometimes partially excluded when old; cortex indistinct to distinct, c. 10–20 μ m thick, 1+ faintly blue (thin sections). *Disc* plane at first, usually becoming markedly convex, \pm smooth, reddish brown to dark brown to blackish, matt. *Epiphyuenum* to 10 μ m tall, brown, unchanged in KOH. *Hymenium* hyaline, 100–120 μ m tall. *Hypothecium* 50–80 (–100) μ m deep, pale yellowish brown, unchanged in KOH. *Paraphyses* not separating easily, simple or occasionally branched, 1–1.5 μ m thick, with apices pigmented brownish, capitate, 3–5 μ m wide; oil paraphyses typically abundant, 4–6.5 μ m thick. *Asci* eight-spored at first, but sometimes reduced to 4–6-spored. *Ascospores* (Fig. 6) two-celled, at first with internal wall thickenings of the *Mischoblastia*-type, then corresponding to the *Pachysporaria*-type, smooth to finely ornamented, brown, (18–)22–31(–33) \times (9–)10–15(–16) μ m, lacking a torus, with the septum not or only barely visible; ontogeny of type A. *Spermogonia* immersed, found mainly at the base of the apothecia. *Spermatia* (Fig. 6d) shortly bacilliform, 3–4 \times 1 μ m.

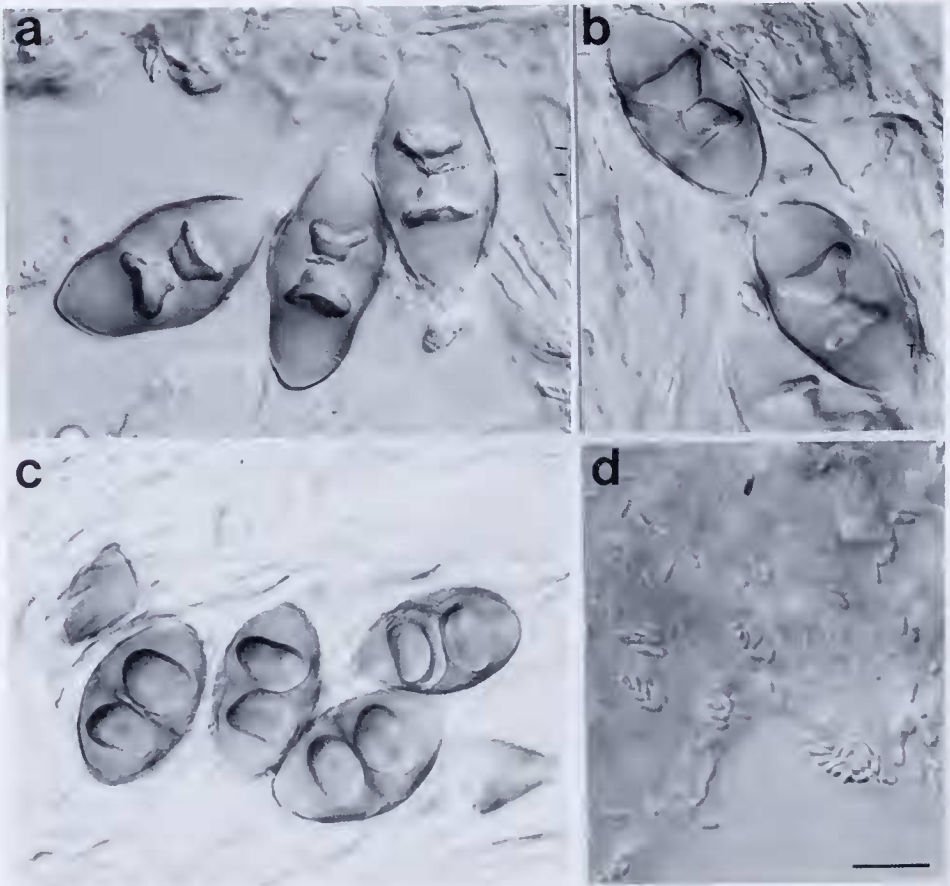


Fig. 6. *Rinodina australiensis* (a-c holotype, d Mayrhofer 2638): premature (a, b) and mature (c) ascospores; short bacilliform spermatia (d). Scale: 10 μ m.

Taxonomic note: The cited sample of the type material of *Rinodina australiensis* was first reported as *Rinodina colobinoides* (Müller 1893a). A second specimen from Queensland (*Shirley 40*) mentioned by Müller (1893b: 124) in the protologue, was not available for study.

Comments: In general, *R. australiensis* is characterized best by its ascospores, at first with internal wall thickenings of the *Mischoblastia*-type, and then corresponding to the *Pachysporaria*-type, and by its thick, well-developed, areolate-crustose to subsquamulose thallus. Morphologically it is rather similar to *R. confusa*, *R. dolichospora* and *R. elixii*, which also have such a thallus. The first of these species is characterized by smaller ascospores of the *Physcia*- or *Pachysporaria*-type with a distinct torus. The other two taxa have large ascospores, *R. elixii* of the *Physcia*-type, and *R. dolichospora* of the *Pachysporaria*-type, frequently with minute, grain-like or droplet-like inclusions. Oil paraphyses are typically very abundant in *R. australiensis*, and the algal cells are relatively large in comparison, for example, to *R. asperata* and *R. dolichospora* with which it may sometimes occur. The former also differs in several other characters, such as having a somewhat thinner thallus and small *Pachysporaria*-type ascospores.

Within this species, we have observed an unusually wide range of ascospore sizes, with the largest being found in asei where the number of mature ascospores is reduced to 4–6. Two specimens from South Australia are particularly unusual in that their ascospores

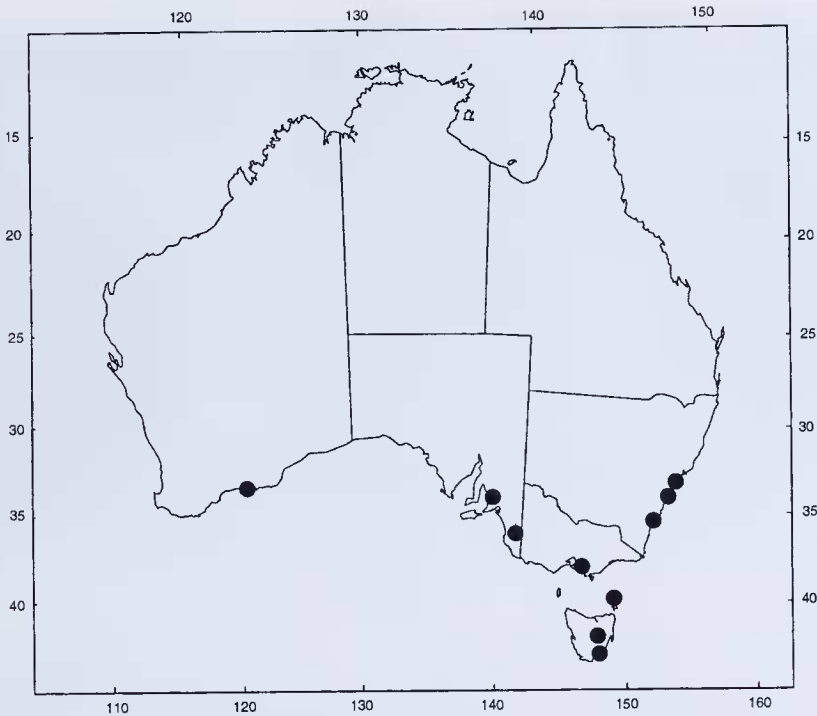


Fig. 7. Distribution of *Rinodina australiensis*.

are very short and rather more squat in shape ($18\text{--}23 \times 10\text{--}13 \mu\text{m}$). This material also has an exceptionally granular, blastidiate thallus, although this may be due to the drier, more exposed habitat. Clearly this species deserves further collection and study, and may require subdivision in the future.

Rinodina australiensis is closely related to the saxicolous maritime *R. blastidiata* Matzer & H. Mayrhofer with which it shares characters of ascospores, oil paraphyses and short spermatia. The latter species is distinguished by the extensive formation of blastidia, the less frequent apothecia, and by its habitat: hard siliceous coastal rocks in south-eastern Australia (South Australia, southern New South Wales, Victoria and Tasmania) and New Zealand (Matzer & Mayrhofer 1994). Although the differences between *R. australiensis* and *R. blastidiata* are not great, we refrain from combining them into one taxon: both are regarded as a pair of closely related species, one of which is saxicolous and the other corticolous or lignicolous. Further examples of such pairs of related species are: the saxicolous *R. gennarii* Bagl. and the corticolous *R. oleae* Bagl. (Matzer & Mayrhofer 1996); and the saxicolous *R. beccariana* Bagl. and the corticolous *R. roboris* (Duf. ex Nyl.) Arnold var. *roboris* (Mayrhofer *et al.* 1993). Additional species closely related to *R. australiensis* include the saxicolous *R. teichophila* (Nyl.) Arnold from the Northern Hemisphere, *R. teichophiloides* (Stizenb.) Zahlbr. from South Africa, and *R. reagens* Matzer & H. Mayrhofer from South Africa and New Zealand (Matzer & Mayrhofer 1994). The illustration of ascospores under the name *R. australiensis* (Filson & Rogers 1979: 157) refers to *R. elixii*.

Ecology and distribution: *Rinodina australiensis* is a lowland species, found in mangroves and sclerophyllous woodland and heathland (Fig. 7). It has been reported from the bark of *Avicennia marina*, *Bursaria spinosa*, *Melaleuca ericifolia*, *Banksia serrata* and *Allocasuarina verticillata*. In mangroves, the species was associated with scattered, poorly developed, unidentified crustose lichens, species of *Pyxine* and

Parvuotrema, and, rarely, *Rinodina asperata* and *R. dolichospora*. However, in sclerophyllous vegetation, especially in Tasmania, it occurs in a species rich community comprising *Teloschistes chrysophthalmus*, *Xanthoria ligulata*, *Rinodina asperata*, species of *Caloplaca* and *Candelariella* and other crustose lichens.

Additional specimens examined: WESTERN AUSTRALIA: Recherche Archipelago, Boxer Island, J.H. Willis, 9.xi.1950 (MEL). SOUTH AUSTRALIA: Christmas Rocks, 29 km S of Keith on Duke Highway, M. & H. Mayrhofer 4683, 15.viii.1981 (GZU, HO); Fred Ratteis Scrub, 7 km W of Springton, M. & H. Mayrhofer 2702, 12.viii.1981 (GZU). NEW SOUTH WALES: Botany Bay, S of Sydney, Towra Point, M. & H. Mayrhofer 2638, 23.viii.1981 (GZU); Hawkesbury River, Mangrove Creek, near Spencer, W. & H. Mayrhofer 6565, 4.i.1985 (GZU); Hawkesbury River, N of Spencer, A. & P. Archer, A. & K. Kalb 26647, 11.viii.1992 (Kalb); Patonga, Patonga Creek, N of Sydney, A. & P. Archer, A. & K. Kalb 25932, 25939, 10.viii.1992 (Kalb); Buckenbowra River, 7.5 km WNW of Batemans Bay, G. Thor 4828, 2.xi.1985 (S); same locality, J.A. Elix & K. Kalb 18232, 18246, 4.viii.1988 (Kalb). VICTORIA: Westernport Bay, Cribb Point, N. Stevens, 15.v.1978 (BR1). TASMANIA: Bass Strait, Furneaux Group, Flinders Island, E side of Long Point, J. S. Whinray, 12.v.1970 (MEL); Tunbridge, G. Kantvilas 160/98, 166/98, 9.ix.1998 (HO); Cape Contrariety, G. Kantvilas 182/98, 25.ix.1998 (HO).

3. *Rinodina confusa* H. Mayrhofer & Kantvilas *sp. nov.*

Thallus crustosus, areolatus ad subsquamulosus, sordide olivaceo-griseus ad olivaceo-brunneus; areolae dispersae ad contiguas, \pm planae sed demum abrasae, lobulatae, granulares vel microphyllinae, interdum \pm blastidiatae. Apothecia dispersa vel paulum aggregata, lecanorina vel lecideina, sessilia. Margo thallina infirme evoluta, margo propria distincta. Ascosporae bicellulares, inspersionibus internis parietis primum typo '*Physcia*' (raro ad typum '*Mischoblastia*' vergentibus), demum typo '*Pachysporaria*' congruentibus, brunneae ad fuscae, \pm laeves, $16\text{--}20 \times 8\text{--}10.5 \mu\text{m}$, toro distincto, in omnibus typis morphologicis ascosporarum visibili.

Type: South Australia, Fred Ratteis Scrub, 7 km W of Springton, on bark of *Casuarina stricta*, 500–530 m altitude, M. & H. Mayrhofer 2700, 12.viii.1981 (holotype GZU; isotype HO).

Thallus crustose, thick and areolate to subsquamulose, dingy olive-grey to olive-brown; areoles dispersed to contiguous, rather indeterminate, \pm plane but becoming abraded, lobulate, granular or microphylline, sometimes \pm blastidiate; prothallus absent. *Photobiont* cells $10\text{--}13 \times 9\text{--}11 \mu\text{m}$. *Chemistry:* no lichen substances detected by t.l.c.

Apothecia 0.2–0.6(–0.8) mm diam., scattered to somewhat clustered, lecanorine to lecideine, mostly sessile. *Thalline margin* usually poorly developed, incomplete, smooth or more commonly nodulose, mainly on the lower side of the apothecium, becoming increasingly excluded with age; proper margin usually distinct, concolorous with the disc, reddish brown to blackish brown; cortex indistinct. *Disc* plane, occasionally becoming convex, smooth to slightly rugose, reddish brown to blackish brown, matt. *Epitymenium* $10\text{--}15 \mu\text{m}$ tall, red-brown to dark brown, unchanged in KOH. *Hymenium* hyaline, $90\text{--}110 \mu\text{m}$ tall. *Hypothecium* hyaline, c. $50 \mu\text{m}$ deep. *Parathecium* well developed, pigmented within. *Paraphyses* not separating easily, mainly simple and branched only near the apices, $1.5\text{--}2 \mu\text{m}$ thick, with apices pigmented brownish, capitate, $3\text{--}4 \mu\text{m}$ wide; oil paraphyses not observed. *Asci* eight-spored. *Ascospores* (Fig. 8) two-celled, at first with internal thickenings of the *Physcia*-type (rarely grading into the *Mischoblastia*-type), then corresponding to the *Pachysporaria*-type, brown to dark brown, \pm smooth-walled, $16\text{--}20 \times 8\text{--}10.5 \mu\text{m}$, with a distinct torus visible in all morphological types; septum visible from the earliest stages, persistent; ontogeny of type A. *Spermatogonia* not found.

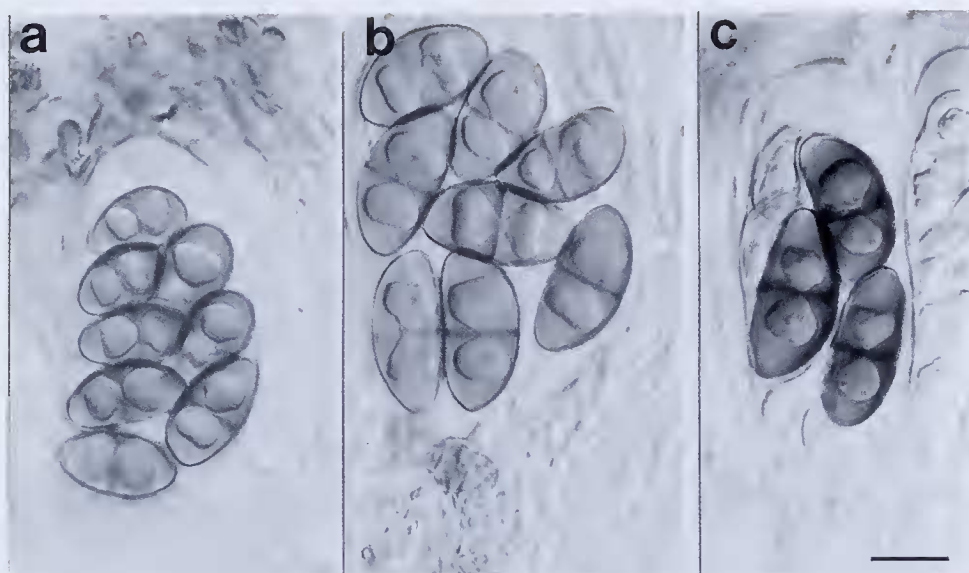


Fig. 8. *Rinodina confusa* (holotype): mature ascospores. Scale: 10 μm .

Comments: As the name implies, this species possesses many enigmatic characters and is therefore difficult to characterise simply. For example, the variability in the spore thickenings is remarkable in that even adjacent asci may contain ascospores of quite different types. Although for the most part, the taxonomy of *Rinodina* depends strongly on spore morphology, such variation is not unique and has also been reported by Giralt & Mayrhofer (1995) in the Macaronesian species, *R. abolescens* H. Magn. Thus in this regard in the Australian flora, *R. confusa* is characterised best by its variable ascospores.

Morphologically, *R. confusa* is most similar to the subsquamulose taxa, *R. australiensis*, *R. dolichospora* and *R. elixii*, but these species all have significantly larger ascospores. *R. dolichospora* also has a completely different ecology, being known only from relatively moist habitats. *Rinodina elixii* differs further in having apothecia which are rather immersed in thalline warts when young. Frequently the thallus of *R. confusa* may become very abraded and granular, and thus may resemble the rather blastidiate forms of *R. australiensis* and, to a lesser extent, *R. asperata*. Nevertheless, the thallus in *R. asperata* is never so well developed, and this taxon also differs in having persistently lecanorine apothecia and small algal cells. Separation from *R. australiensis* is more difficult, and whereas subtle thalline characters may be of help, this can be achieved with certainty only by careful study of the ascospores.

There remains one specimen (A.C.T.: Molongolo Gorge Reserve, *Mayrhofer 10983* & *Elix*, GZU), clearly closely related to *R. confusa*, which we have been unable to place with certainty. It has a very similar thallus, although neither abraded nor lobulate-granular, and persistently lecanorine apothecia. This specimen has the variable ascospores of *R. confusa*, but these are marginally shorter and narrower, 15–19 \times 7.5–9 μm , with a thinner hymenium (70–90 μm) and larger photobiont cells (15–25 \times 13–20 μm). Further collections of such material are required in order to identify it accurately.

R. confusa is related to the Macaronesian species *R. abolescens* which is distinguished by the presence of a distinct, I+ blue cortex and a much thinner and discontinuous thallus (Giralt & Mayrhofer 1995).

Ecology and distribution: *Rinodina confusa* is only known from the type locality, where it grew abundantly on the rough bark of *Casuarina stricta* in dry sclerophyll forest. Associated lichens, growing on the specimens, include depauperate fragments of *Physcia adscendens* and species of *Candelariella* and *Caloplaca*.

4. *Rinodiua couradii* Körb. *Syst. Lich. Germ.*: 123 (1855). *Type*: without locality, 'Typenherbar Körper' (lectotype, here designated, L!).

Thallus crustose, thin or evanescent to rather thick and well developed, seldom areolate, finely verrucose to granular, cream-coloured to grey-brown or brown; prothallus absent. *Photobiont* cells $13\text{--}20 \times 12\text{--}15 \mu\text{m}$. *Chemistry*: no lichen substances detected by t.l.c.



Fig. 9. a–c *Rinodiua couradii* (Tibell 14099, GZU). a ascus with young ascospores where internal spore wall thickenings appear before the insertion of the septum; b immature ascospore (right) as of the *Physcia*-type; c mature ascospores. d–f *Rinodiua connectens* (Atherton Tableland, Mt Lewis, 18.iv.1968, W.A. Weber; COLO). d immature ascospores with bone-shaped lumina; e mature ascospores. Scales: $10 \mu\text{m}$

Apothecia 0.2–1 mm diam., scattered or crowded, lecanorine, sessile to adnate. *Thalline margin* prominent, concolorous with the thallus, smooth and entire, or softly ridged, generally persistent; cortex indistinct. *Disc* plane, soon becoming convex, reddish brown, black-brown to black, matt. *Ephymenium* 10–15 µm tall, red-brown, unchanged in KOH. *Hymenium* hyaline, 120–150 µm tall. *Hypothecium* hyaline, 50–100 µm deep. *Parathecium* 25–40 µm thick, hyaline except at the upper edge. *Paraphyses* separating easily, 1.5–2 µm thick; apices capitate, pigmented red-brown, 3–4 µm wide; oil paraphyses frequent, 4.5–6 µm thick. *Asci* eight-spored. *Ascospores* (Figs 3a, 9a–c) 4-celled when mature, lumina of immature two-celled ascospores like those of the *Physcia*-type, 23–29.5 × (10–)11–13 µm; torus indistinct; central septum distinct and persistent, other septa very indistinct; ontogeny of type B (Fig. 2). *Spermagonia* not observed.

Taxonomic note: Körber (1855) listed three localities in his description of *Rinodina conradii*. There is only one specimen, without locality or annotation, in his herbarium which matches well with his description; this we designate as the lectotype.

Comments: *Rinodina conradii* is an extremely variable species as regards the morphology of the thallus and the structure of the apothecia. It is well characterised and separated from the other species treated by its ascospores, which are four-celled when mature. In young ascospores, the septum is inserted after the formation of internal apical wall thickenings. In contrast, *R. connectens* Malme, a species described from subtropical South America and also occurring in subtropical to tropical rainforests of Queensland, has four-celled ascospores (when mature) but, in young ascospores, the septum is inserted before the formation of internal wall thickenings and the lumina of premature two-celled ascospores are bone-shaped rather than *Physcia*-like (Figs. 3B, 9d–e).

Ecology and distribution: *Rinodina conradii* is a widespread temperate species occurring throughout the boreal zone of northern Europe and in the Alps, in western North America, South America including the high mountainous regions in the tropics, and the Himalayan mountains (Krenn 1994, Mayrhofer & Krenn, in prep.). It was reported from Tasmania by Mayrhofer (1984b), and from New Zealand by Nylander (1888, as *Lecanora pyreniospora* var. *paupercola*), Hellbom (1896, as *Rinodina conradii* var. *sepincola*) and Mayrhofer (1985).

The species occurs on a wide range of substrates including plant debris, mosses, lichens, lignum, bark, thatch, the faeces of sheep and rabbits, and peat (Krenn 1994). Only those specimens growing on bark and lignum are listed below. In Tasmania, the species overgrows terricolous bryophytes and dead grasses in rough pasture.

Specimens examined: AUSTRALIA, WESTERN AUSTRALIA: Walpole National Park, 2 km SW of Walpole, along Rest Point Road, *L. Tibell* 14099, 12.x.1983 (GZU, PERTH, UPS); Busselton, Layman Road, near Wonnerup House, *N. Sammy*, 31.xii.1981 (PERTH). NEW ZEALAND: Southland, Monowai River, 2 km E of Lake Monowai, *A. Henssen & H. Mayrhofer* 2175, 22.ix.1981 (GZU).

5. *Rinodina dolichospora* Malme, *Bihang K. Svenska Vet.-Akad. Handl.* 28 (III/1): 30 (1902). *Type:* Brazil, Matto Grosso, Santo Antonio, Morro Grande, ad truncum dejectum in silvula humidam, *G.O. Malme* 2159, 20.xii.1893 (lectotype, here designated, S!). *Paratypes:* Brazil: Rio de Janeiro, Corcovado, Paneiras, *G.O. Malme* 344, 4.ix.1892 (S!); Rio Grande do Sul, Porto Alegre, *G.O. Malme* 663, 5.xi.1892 (S!); Rio Grande do Sul, excolonia Silveirae Martins pr. Santa Maria, *G.O. Malme* 1209B, 20.iii.1893 (S!).

Thallus crustose, thin and effuse or, more typically, rather thick, areolate to subsquamulose, pale olive-grey to olive brownish; areoles contiguous and fusing to discrete and ± dispersed, *c.* 0.3–1 mm wide, flat, convex or concave with ascending margins, at times somewhat microphylline or lobulate; prothallus black, thin, sometimes evident between the areoles. *Photobiont cells* 7–9 × 6–7 µm. *Chemistry:* no lichen substances detected by t.l.c.

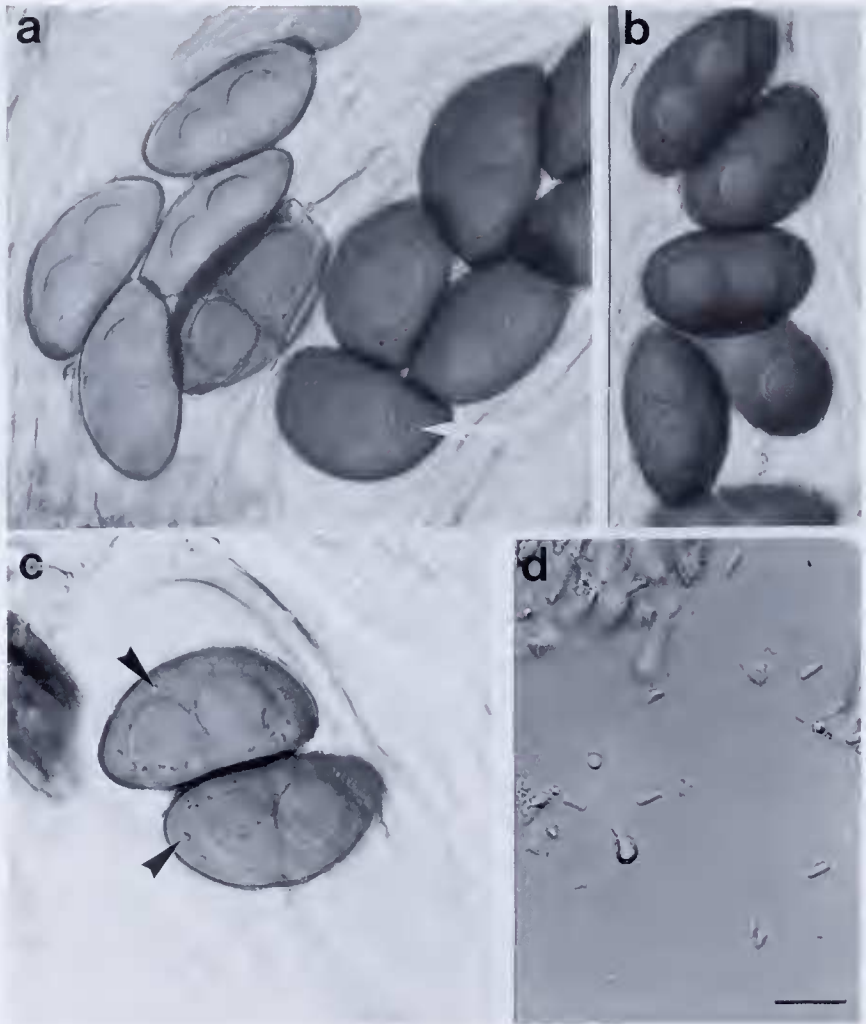


Fig. 10. *Rinodina dolichospora* (a, b, d Thor 4827, c lectotype). a–c immature and mature ascospores with minute, scattered, globular, droplet like inclusions within the spore wall (arrow); d bacilliform spermatia. Scale: 10 μ m.

Apothecia 0.2–0.8(–1) mm diam., scattered, \pm lecanorine, sessile. *Thalline margin* well developed, occasionally \pm coronate, or incomplete and only partially enveloping a distinct pale brown to brown proper margin; cortex to 30 μ m thick, composed of globose hyphae, 4–5 μ m diam. *Disc* plane to undulate, rarely becoming convex, smooth, dark brown to blackish, matt. *Epihymenium* 10–15 μ m tall, orange-brown to dark brown, unchanged in KOH. *Hymenium* hyaline, 100–130 μ m tall. *Hypothecium* 100–120 μ m deep, hyaline to pale yellowish. *Parathecium* well developed, up to 50–60 μ m thick at the upper edge, typically with a hyaline epinecral layer to 20 μ m thick. *Paraphyses* separating rather easily, simple or occasionally branched in the upper part, 1.5–2 μ m thick, with apices dark brown, capitate, 2–4 μ m wide; oil paraphyses absent. *Asci* eight-spored or reduced to six. *Ascospores* (Fig. 10) two-celled, of the *Pachysporaria*-type, occasionally one-celled, smooth-walled, dark brown, 24–30.5 \times 12.5–16 μ m, frequently with minute grain-like or droplet-like inclusions; torus indistinct; septum distinct only in mature ascospores; ontogeny of type A. *Spermogonia* immersed, discernible as bulges in the

thallus surface, pierced by a minute, pale brown ostiole. *Spermatia* (Fig. 10d) bacilliform, $4.5\text{--}6 \times 1.5 \mu\text{m}$.

Comments: This represents the first record of *Rinodina dolichospora* from Australia. Our specimens accord closely with the type collections of Malme, which differ only very slightly in having ascospores within the range cited above but up to $33 \mu\text{m}$ long and a hymenium to $140 \mu\text{m}$ thick. In addition, the anatomical features of the apothecial margin are not as well developed in the type collection: the epinecral layer is only *c.* $5 \mu\text{m}$ thick and the cortex is only $5\text{--}10 \mu\text{m}$ thick. At least part of the type material appears to be from lignum.

Morphologically, *R. dolichospora* most closely resembles the other \pm subsquamulose taxa, *R. australiensis*, *R. confusa* and *R. elixii*, and like these species, sometimes appears superficially like a small species of *Pannaria* or *Parmeliella*. In the case of *R. dolichospora* in particular, the apothecia are generally more sessile (rather than adnate to sunken), and their thalline margin may be rather coronate. Like *R. australiensis* and *R. elixii*, *R. dolichospora* also has large ascospores. *R. dolichospora* differs by having small photobiont cells, paraphyses which separate easily in squash mounts, and by lacking oil paraphyses. Another unique feature of the species is the presence of minute, scattered, globular inclusions within the spore wall.

The oceanic *Rinodina confinis* Samp. from south-western Europe may be a synonym of *R. dolichospora* (Giralt & Mayrhofer 1995, Giralt & Mayrhofer, in prep.).

Ecology and distribution: This species is known in Australia from two localities in coastal New South Wales, where it was recorded from the bark of *Casuarina cunninghamiana* and *C. glauca* in swamps and mangroves. Associated lichens include *Punctelia subflava*, *Rinodina asperata* and *Normandina pulchella*.

Additional specimens examined: NEW SOUTH WALES: Buckenbowra River, 7.5 km WNW of Batemans Bay, *G. Thor* 4827, 2.xi.1985 (S); same locality *H. Streimann* 35824 & *J.A. Curnow* (CANB); Red Rock, Corindi Creek, *G. Kantvilas* 129/98, 19.iv.1998 (GZU, HO).

6. *Rinodina elixii* H. Mayrhofer, Kantvilas & Ropin *sp. nov.*

Thallus crustosus, crassus, areolatus ad subsquamulosus, pallide olivaceo-griseus ad olivaceo-viridis; areolae contiguae et coalescentes, planae, firme adnatae, interdum aliquantum abrasae et lobulatae. Apothecia dispersa vel aggregata, lecanorina, primum thallo immersa, demum per fissuris laceratis erumpentia, mature aliquantum impressa vel adnata vel sessilia. Hymenium in sectione longitudinali hyalinum, $130\text{--}150 \mu\text{m}$ altum; hypothecium $100\text{--}150 \mu\text{m}$ altum, hyalinum ad flavo-brunneum. Asci 8-spori, interdum 4–6-spori. Ascosporae bicellulares, typo '*Physcia*', fuscae, $23\text{--}30 \times 12.5\text{--}16 \mu\text{m}$, parietibus scaberulis, toro distincto. *Spermatia* bacilliformia, $4\text{--}5 \times 1 \mu\text{m}$.

Type: Victoria, Copi Flats, south side of Wyperfeld National Park, on *Callitris* sp., *M. & H. Mayrhofer* 4710, 18.viii.1981 (holotype GZU; isotypes UPS, HO).

Thallus crustose, thick and areolate to subsquamulose, pale olive-grey to olive-green; areoles contiguous and coalescing, mostly $0.2\text{--}0.5 \text{ mm}$ wide, plane and tightly adnate, at times rather abraded and lobulate; prothallus absent. *Photobiont* cells $10\text{--}20 \times (5\text{--})9\text{--}15 \mu\text{m}$. *Chemistry:* no lichen substances detected by t.l.c.

Apothecia $0.4\text{--}1 \text{ mm}$ diam., scattered to crowded, occasionally overlapping, \pm lecanorine, at first immersed in the thallus, soon emerging through ragged fissures, rather sunken, adnate or sessile when mature. *Thalline margin* ragged initially, derived from adhering thalline fragments, becoming \pm smooth and entire, ultimately very thin to absent; proper margin very thin or inapparent, concolorous with the disc; cortex to $10\text{--}20 \mu\text{m}$ thick, composed of thickly packed, elongate hyphae. *Disc* plane or concave at first, becoming undulate to markedly convex, smooth to roughened, brownish black, matt. *Epihymenium* $10\text{--}20 \mu\text{m}$ tall, brown, unchanged in KOH. *Hymenium* hyaline,

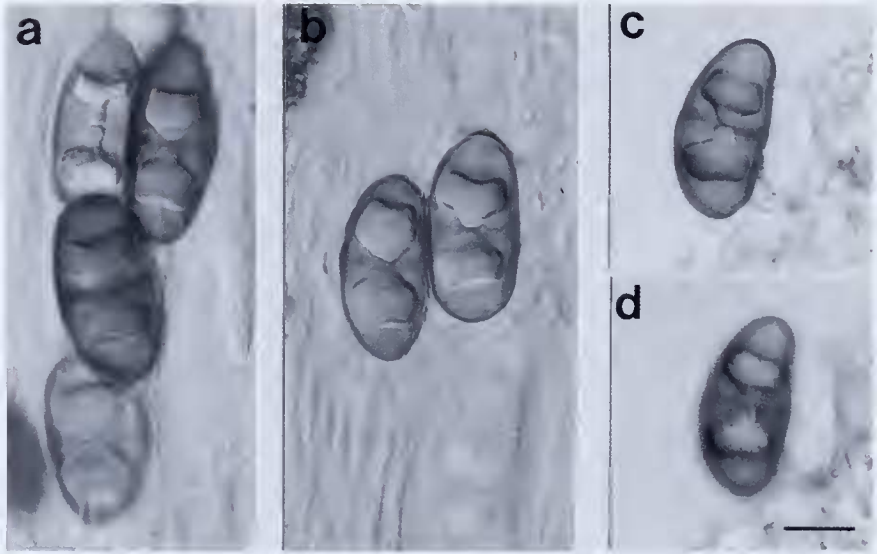


Fig. 11. *Rinodina elixii* (holotype): mature ascospores; c and d are in different focus in order to show the minutely scabrid spore wall. Scale: 10 μ m.

130–150 μ m tall. *Hypothecium* 100–150 μ m deep, hyaline to yellow-brown. *Parathecium* rather well developed, pale brown, to c. 40 μ m thick with a hyaline epinceral layer, 5–10 μ m thick. Paraphyses to 1.5 μ m thick, not separating easily, branched only in the upper part, with capitate, brown-pigmented apices, 3–5 μ m wide; oil paraphyses occasional, 5–6 μ m thick. *Asci* eight-spored, sometimes reduced to 4–6 spored. *Ascospores* (Fig. 11) two-celled, of the *Physcia*-type, dark brown, 23–30 \times 12.5–16 μ m; wall minutely scabrid; torus distinct; septum distinct and persistent; ontogeny of type A. *Spermatogonia* immersed in the thallus, with a hyaline wall and a slightly raised, brown ostiole. *Spermatia* bacilliform, 4–5 \times 1 μ m.

Etyymology: This species is named in honour of our friend and colleague, Professor Jack Elix who has made outstanding contributions to lichenology in Australia.

Comments: *Rinodina elixii* is a very distinctive lichen, characterised by a thick, crustose to subsquamulose thallus, large *Physcia*-type ascospores and large photobiont cells. The spore wall is minutely scabrid, but this is generally observable only with a high quality light microscope. On the basis of thallus morphology alone, *R. elixii* is most closely related to *R. australiensis*, *R. confusa* and *R. dolichospora*. However, in well developed material, *R. elixii* tends to be recognisable by the distinctive ontogeny of the apothecia: these are formed in thalline warts which rupture and the apothecium emerges with thalline fragments adhering to its margin, rather like that described in some species of *Sarraucana* by Kantvilas & Vězda (1996). These fragments fuse and abrade, and ultimately form a \pm complete, 'leanorine' apothecial margin. A similar type of development is seen in *R. obscura*, which likewise has *Physcia*-type ascospores, albeit markedly smaller. However, this species differs further in having a very thin to almost absent crustose thallus and the thalline margin frequently becomes almost entirely excluded.

With respect to the size and type of ascospores and hypothecium characters, *R. elixii* is most closely related to the Arctic-alpine taxon *R. uniaraea* var. *uniaraea* which occurs almost exclusively on mosses and plant debris (Magnusson 1947, Timpe 1991, Mayrhofer *et al.*, in prep.).

Ecology and distribution: *Rinodina elixii* appears to be a rare species, known from only two localities in rather dry areas of south-eastern Australia, where it grew on the

lignum and bark of species of *Callitris* and *Brachychiton*. The specimens studied are associated with fragments of species of *Candelariella*, *Caloplaca* and *Flavoparmelia*.

Other specimen examined: NEW SOUTH WALES: Cabonne, c. 5 km S of Molong, D., M. & H. Mayrhofer 8589, 12.viii.1988 (GZU).

7. *Rinodina obscura* Müll. Arg., *Bull. Herb. Boissier* 1: 40 (1893). *Type*: Victoria, Oakleigh, F.R.M. Wilson 745, 1892 (holotype G!).

Thallus crustose, very thin and effuse and almost inapparent to moderately thick and areolate, dingy olive-grey to olive-brown, rarely pale grey; areoles dispersed or contiguous, 0.1–0.3 mm wide; prothallus absent. *Photobiont* cells 7–9 × 6–8 µm. *Chemistry*: no lichen substances detected by t.l.c.

Apothecia 0.2–0.8(–1) mm diam., scattered, at first ± immersed in the thallus, soon emerging, sessile to adnate. *Thalline margin* at first ragged and ± incomplete, becoming smooth to rather abraded, increasingly excluded with age and often apparent only on the underside of the apothecium; proper margin very thin, black to dark brown, sometimes inapparent; cortex to 20 µm thick, composed of densely interwoven hyphae. *Disc* plane to undulate, occasionally convex, smooth to roughened, black, matt. *Epilhymenium* 10–20 µm tall, dark brown, unchanged in KOH. *Hymenium* hyaline, 80–100 µm tall. *Hypothecium* hyaline to pale yellowish brown, (40–)80–150 µm deep. *Parathecium* very well developed, brown to yellowish brown, (25–)40–50 µm thick, with a hyaline epinecral layer to 5 µm thick. *Paraphyses* 1.5–2 µm thick, not separating easily, branched only in the upper part, with capitate, brown-pigmented apices 2.5–4 µm wide; oil paraphyses occasional, 6–7 µm thick. *Asci* eight-spored. *Ascospores* (Fig. 12) two-celled, of the *Physcia*-type, dark brown, 16–20 × 6–9 µm, smooth; torus distinct; septum persistent; ontogeny of type A. *Spermatogonia* immersed in the thallus. *Spermatia* bacilliform, 3.5–4.5 × 1.5 µm.

Comments: With its *Physcia*-type ascospores, this species is related to *R. elixii*, differing mainly in that the latter has a much better developed, thicker, often subsquamulose thallus, larger ascospores with minutely roughened walls, larger photobiont cells and somewhat longer, more slender spermatia. Otherwise, many of the

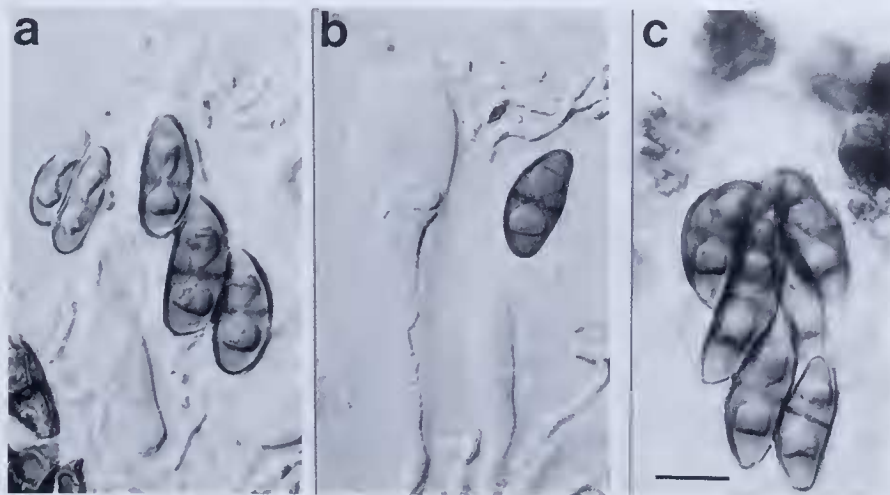


Fig. 12. *Rinodina obscura* (a, b holotype; c Mayrhofer 4628): immature (a) and mature (b-c) ascospores with distinct torus. Scale: 10 µm.

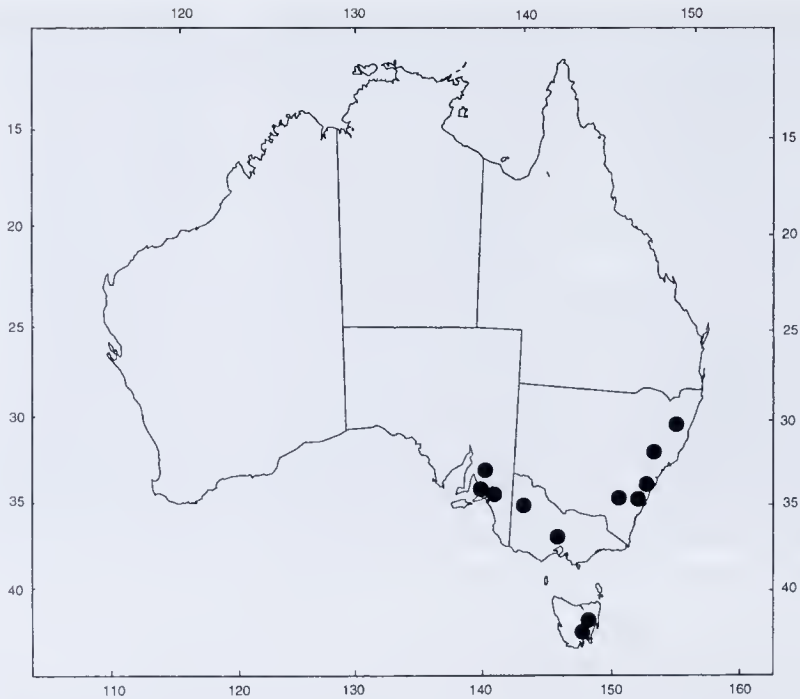


Fig. 13. Distribution of *Rinodina obscura*.

anatomical characters of these two taxa are identical and, furthermore, both display a similar type of development of the apothecia and their thalline margin (i.e. the apothecium emerges from the thallus with adhering thalline fragments that ultimately comprise the thalline margin). In *R. obscura*, this thalline margin finally becomes extremely reduced, to the point where the apothecia look lecideine and *Buellia*-like. Superficially, this species is somewhat similar to *R. asperata*, in that both have a rather thin, poorly developed thallus. However, the clearly lecanorine apothecia of the latter are distinctive and provide a valuable macroscopic aid to their separation. Whilst the dimensions of the ascospores and photobiont cells of these two taxa are similar, *R. asperata* differs in having *Paclysporaria*-type ascospores.

Rinodina obscura differs from its closest European relatives, *R. septentrionalis* Malme and *R. ventricosa* Hinteregger & Giralt, by its darker thallus, by its apothecia which are not constricted at the base and have a thalline margin becoming increasingly excluded with age, and by a thicker hypothecium.

Ecology and distribution: *Rinodina obscura* is a species of low rainfall areas of south-eastern Australia and eastern Tasmania (Fig. 13), where it occurs on rough, living or dead bark and on lignum in dry sclerophyll forest, mainly at low altitudes. Frequent host trees include species of *Allocasuarina*, *Eucalyptus* and *Acacia*. This lichen belongs to a very typical association of epiphytic dry woodland lichens, such as *Buellia* (*Hafellia*) *dissa*, *B. griseovirens*, *Candelariella xanthostigmoides*, *Pyrrhospora laeta*, *Rinodina asperata*, *Flavoparmelia rutidota*, *Parmelina conlabrosa* and species of *Caloplaca*, *Ramalina* and *Pertusaria*.

Additional specimens examined: SOUTH AUSTRALIA: about 5 km W of Oodla Wirra, R.W. Rogers 1625, 27.ii.1969 (BR1); Kuitpo Forest, 10 km E of Willunga, M. & H. Mayrhofer 4628, 14.viii.1981 (GZU); Kyeema Conservation Park, 21 km E of Willunga, M. & H. Mayrhofer 6675, 14.viii.1981

(GZU); summit of Mount Barker, 32 km SE of Adelaide, *M. & H. Mayrhofer* 2688, 11.viii.1981 (GZU). NEW SOUTH WALES: New England, Armidale Distr., Woilomombi Falls Reserve, E of Armidale, Edgars Lookout, c. 950 m, *H. Mayrhofer* 4650, 5384 & *J. Williams*, 12.x.1981 (GZU); 5525 (HO); same locality, *W.A. Weber & D. McVean*, 24.x.1967 (COLO); Bungonia Lookdown, rim of Shoalhaven River Gorge, 11 km E of Bungonia, *W.A. Weber & D. McVean*, 10.iv.1968 (COLO); Muswellbrook, between Sandy Hollow and Hollydeen, W of Muswellbrook, *D., M. & H. Mayrhofer* 8853, 14.viii.1988 (GZU, HO, Mayrhofer); Wanganderry Tableland, Lake Burrarorang, near Wollondilly River, E of Byrnes Bay, SSW of 'The Oaks', *H. Mayrhofer* 4670a, 3.x.1981 (GZU); S of Boorowa River, NW of Yass, *D., M. & H. Mayrhofer* 8585, 11.viii.1988 (GZU). VICTORIA: Copi Flats, S side of Wyperfield National Park, 125 km N of Horsham, *M. & H. Mayrhofer* 4624, 18.viii.1981 (GZU, MEL). TASMANIA: New Norfolk, *H. Mayrhofer* 12015, *E. Hierzler & G. Kantvilas*, 3.viii.1992 (GZU); 7 km E of Lake Leake, *G. Kantvilas*, 22.v.1996 (HO).

8. *Rinodina pyrina* (Ach.) Arnold, *Flora* 64: 196 (1881); *Lichen pyrinus* Ach., *Lichenogr. Suec. Prodr.*: 52 (1798). *Type*: without collector or locality (lectotype, *fide* Ropin & Mayrhofer 1993, BM-ACH!).

Thallus crustose, rather thin and effuse, to moderately thick and areolate, often scabrid and mealy, pale grey to dingy olive-grey; areoles typically minute, somewhat dispersed and discontinuous, especially at the margins, contiguous in the centre of the thallus, plane to convex to \pm bullate; prothallus absent. *Photobiont* cells $16\text{--}22 \times 14\text{--}20 \mu\text{m}$. *Chemistry*: no lichen substances detected by t.l.c.

Apothecia 0.1–0.6 mm diam., scattered, typically very numerous, lecanorine, sessile when mature but sometimes rather immersed when young. *Thalline margin* well developed, thin, entire, occasionally abraded, persistent even in old apothecia; cortex indistinct, 5–10 μm thick, composed of interwoven hyphae. *Disc* plane, occasionally becoming convex, brown to black, matt, usually somewhat scabrid. *Epihymenium* 5–10 μm tall, brown to dark brown, unchanged in KOH. *Hymenium* hyaline, 60–70 μm tall. *Hypothecium* 50–60 μm deep, hyaline. *Parathecium* poorly developed and rather indistinct, mostly *c.* 20–50 μm thick. *Paraphyses* simple or branched occasionally near

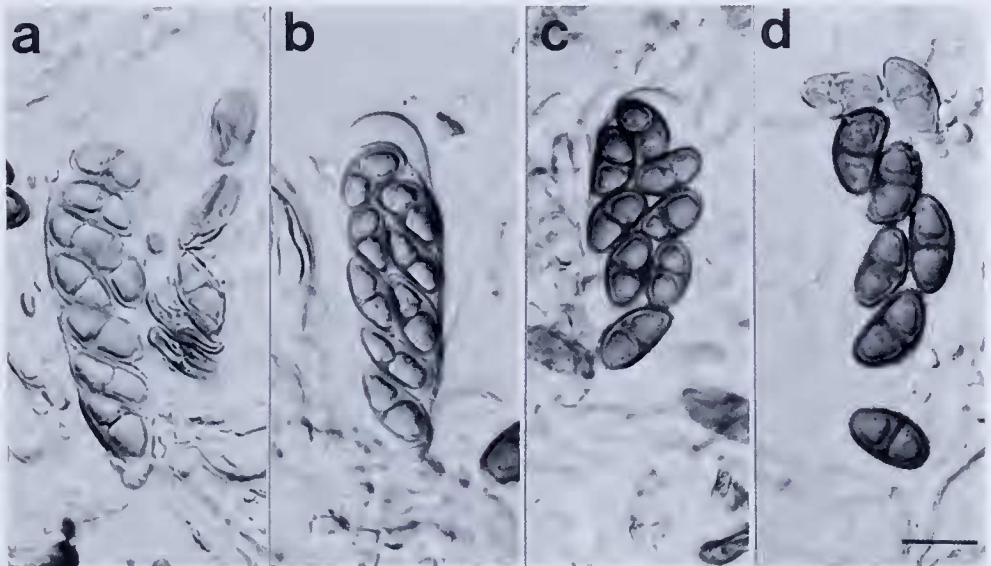


Fig. 14. *Rinodina pyrina* (Kantvilas 209/89, GZU): **a** ascus with immature ascospores; **b-d** mature ascospores. Scale: 10 μm .

the apices, separating easily, 1.5–2 µm thick; apices dark brown, capitate, 4–6 µm wide; oil paraphyses not observed. *Asci* eight-spored. *Ascospores* (Fig. 14) two-celled, of the *Physconia*-type, often slightly curved, with faint median thickenings but lacking distinct apical thickenings when mature, pale to dark brown, generally smooth-walled, 12–15(–17) × 5–7 µm; torus sometimes evident; septum distinct and persistent at maturity; ontogeny of type *A. Spermogonia* not seen.

Comments: The above description is based solely on collections from the study area, but compares favourably in all salient features to other published accounts of material from Europe (see Giralt & Mayrhofer 1995, Ropin & Mayrhofer 1993). *Rinodiua pyriua* is well characterised by its ascospores which, unlike those of any other taxon in this study, lack the wall thickenings that characterise most *Rinodiua* species. Instead, at maturity, the ascospores lack any apical thickenings and the median thickenings at the septum are often so reduced that the ascospores appear *Buellia*- or *Physconia*-type in the traditional sense of, for example, Scheidegger (1993). Although we report the ascospores as being smooth-walled, some were very minutely roughened, but not to the extent of *R. elixii* and thus not to a degree to be easily observed. Also quite distinctive are the very large photobiont cells, which have also been observed by previous workers (e.g. Magnusson 1947).

The relatively thin, small, crustose thallus of *R. pyriua*, and its persistently lecanorine apothecia make it superficially most similar to *R. asperata*, although even macroscopically, the two taxa differ by the somewhat more dingy olive thallus and larger apothecia of the latter. There are also quite distinctive ecological differences between the two.

Ecology and distribution: At present, this species is known in Australia almost exclusively from the trunks, branches and twigs of exotic trees and shrubs, for example, *Corylus*, *Ficus*, *Morus*, *Malus*, *Populus*, *Salix* and *Fraxinus*, in gardens, pastures and along roadsides. The sole collection from a native host (*Bursaria spinosa*) was from a disturbed roadside in Tasmania. We can also confirm its occurrence in New Zealand, also on introduced hosts. It is frequently the first colonizer of the youngest twigs in such habitats. Associated lichens include species typical of exposed, often nutrient-enriched habitats, such as *Xanthoria parietina*, *Physcia adscendeus*, *Punctelia subrudecta*, *Flavoparmelia rutidota* and species of *Caloplaca* and *Lecanora*. In our experience, *R. pyriua* is unknown in native vegetation (where it is essentially replaced by *R. asperata*) and thus there is a strong possibility that it has been introduced together with its hosts. The same may also be true of its cosmopolitan associate, *X. parietina*.

Specimens examined: SOUTH AUSTRALIA: Eudunda to Morgan Road, 6 km E of Mount Mary, *M. & H. Mayrhofer* 2718, 2741, 13.viii.1981 (GZU). AUSTRALIAN CAPITAL TERRITORY: Hawker, 10 km NW of Canberra, *H. Streimann* 10358, 22.vi.1980 (CANB). TASMANIA: Hobart, The Cascades, *G. Kantvilas* 208/89, 209/89, 13.viii.1989 (GZU, HO); Hobart, Mt Stuart Road, *G. Kantvilas* 735/84, x.1984 (HO); Constitution Hill, *G.C. Bratt & M. H. Bratt* 3106 (HO); Tunbridge, *G. Kantvilas* 158/98, 9.ix.1998 (HO). NEW ZEALAND: Canterbury, Canterbury Plains, Bankside Scientific Reserve, SE of Bankside, *H. Mayrhofer* 9016, 9021, *H. Hertel, C.D. Meurk & B.P.J. Molloy*, 14.i.1985 (GZU); Otago, Alexandra, Little Valley Road, 6 km from Alexandra, *H. Mayrhofer* 9720, *H. Hertel & P. Child*, 2.ii.1985 (GZU); Otago, Fruitlands, 12 km S of Alexandra, 460 m, *V. Wirth* 28539 & *C.D. Meurk*, 6.xi.1981 (STU).

Excluded Taxa

Rinodina archaea (Ach.) Arnold. This species has been cited in numerous checklists for Australia (Filson 1983, 1986, 1987, 1988, 1996; McCarthy 1991) but does not appear to be substantiated by any specimens.

Rinodina colobinoides (Nyl.) Zahlbr. The record of Müller (1893a) refers to *Rinodiua australiensis* (see above).

Rinodina exigua (Ach.) Gray. The records of Shirley (1889) as *Lecanora exigua* from Queensland, and Jatta (1911) from Tasmania remain doubtful, because we have not been able to examine the cited specimens.

Rinodina glomerella (Stirt.) Zahlbr. This species was described from Queensland (Bailey 1899). According to the protologue it belongs to *Buellia*.

Amandinea insperata (Nyl.) H. Mayrhofer & Ropin *comb. nov.*; *Lecanora insperata* Nyl., *Lich. Nov. Granat.* 1: 443 (1863). Type: [South America, Colombia] Nova Granata, Bogota: A. Lindig 2616, 1860 (lectotype, *fide* Aptroot 1987, H-NYL 28494!; isolectotypes H-NYL 28493!, H-NYL p.m. 2902!, 2903!, 9541); *Lecidea insperata* (Nyl.) Nyl., *Flora* 63: 128 (1880); *Rinodina insperata* (Nyl.) Malme, *Bihang K. Svenska Vet.-Akad. Handl.* 28(III/1): 44 (1902).

Rinodina propior (Nyl.) Müll. Arg., *Bull. Herb. Boissier* 2, App. 1: 52 (1894); *Lecanora propior* Nyl., *Lich. Nov. Zel.*: 60 (1888). Type: New Zealand, no further details, C. Knight, 1868 (holotype H-NYL 30049!).

Thallus crustose, smooth and thin or rather thick, rimose-areolate or verrucose, sordid whitish, light brown to light grey; prothallus absent. *Photobiont* cells 12–16 × 10–14 µm. *Chemistry*: no lichen substances detected by t.l.c.

Apothecia 0.4–0.5 mm diam., scattered or crowded, lecanorine at first, becoming biatorine and finally lecideine, immersed to adnate. *Thalline margin* initially prominent and concolorous with the thallus, soon reduced; cortex indistinct. *Disc* plane to convex, black, matt. *Epithemium* to 10 µm tall, reddish brown to dark brown, unchanged in KOH. *Hymenium* 70–90 µm tall, hyaline. *Hypothecium* 50–70 µm deep, dark brown. *Paraphyses* simple or branched, 1–1.5 µm thick, with apices pigmented reddish brown to dark brown, 4–8 µm wide. *Asci* clavate, corresponding to the *Bacidia*-type (Rambold *et al.* 1994), eight-spored. *Ascospores* (Fig. 15) two-celled, of the *Orcularia*-type, pale-yellowish to pale brown, 14–19 × 6–8 µm, smooth; torus absent; septum indistinct; ontogeny of type A. *Spermatia* immersed. *Spermatia* filiform, 25–30 × 1 µm.

Comment: *Amandinea insperata* is characterised by the variable apothecia, *Orcularia*-type ascospores, the *Bacidia*-type asci, the brown hypothecium and the filiform spermatia. It is well separated from *Rinodina* (where it has been informally

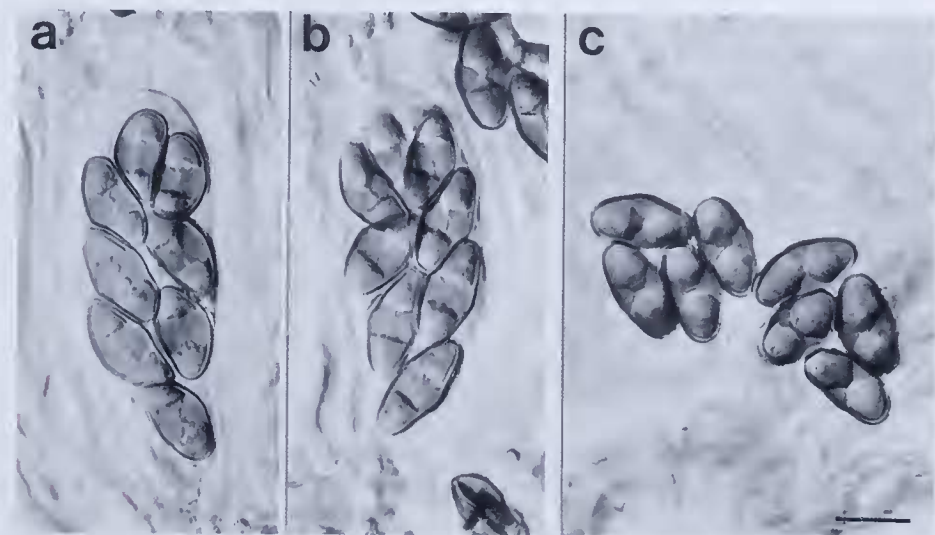


Fig. 15. *Amandinea insperata* (Wilson, 1890, G): a–b immature ascospores; c mature ascospores. Scale: 10 µm.

included at times) by the different ascus-type and the filiform spermatia. These characters place this remarkable species in the genus *Amandinea* M. Choisy ex Scheid. & H. Mayrhofer, which was reinstated by Scheidegger (1993).

Ecology and distribution: *Amandinea insperata* is known from several older herbarium collections from introduced trees in Victoria. More recent records from southern Queensland are from *Avicennia*. The Tasmanian record is from the bark of a coastal, wind-swept *Allocasuarina verticillata*, where it was associated with *Teloschistes chrysophthalmus*, *Rinodina anstraliensis*, *R. asperata* and species of *Bnellia*. *Amandinea insperata* is also known from New Zealand.

Selected specimens examined: QUEENSLAND: Brisbane, Boondall, Sandgate Road/Brown Street, C. Scarlett & N. Stevens, 4.ix.1975 (BRI); Fraser Island, 1 km S of Eurong Beach, J. A. Elix 22909, 5.vii.1989 (CANB). VICTORIA: Kew, F.R.M. Wilson, iii.1896 (UPS); Malvern, F.R.M. Wilson 690, 9.viii.1886, 1890 (G); C. Knight 219, 223, 1887 (G). TASMANIA: Cape Contrariety, G. Kantvilas 185/98, 25.ix.1998 (HO). NEW ZEALAND: Nelson, Golden Bay, E of Takaka, H. Mayrhofer 12024, 12025, 28.viii.1992 (GZU).

Rinodina metabolica (Ach.) Anzi. Müller (1893a) lists three specimens from Victoria collected by Wilson. The specimen from Maffra (*Wilson 698*) refers to *Rinodina asperata*, the specimen from Camperdown (*Wilson 694*) remains enigmatic and is provisionally included in *R. asperata* (see comments under *R. asperata*), whilst the specimen from Malvern (*Wilson 690*) refers to *Amandinea insperata* (see above).

Rinodina metabolica var. *phaeocarpa* Müll. Arg. The record of Müller (1893a) from Victoria refers to *Amandinea insperata*.

Rinodina placomorpha (Stirt.) Zahlbr. This species was described from Queensland (Bailey 1899). According to the protologue it belongs to *Bnellia*.

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